the array of cells, reads or writes data on an optical disk in the cartridge. After the reading or writing operation, the cartridge is replaced in its original cell. The system uses shaft encoders on two motors of the two control systems, and current or voltage feedback from the motors, for all positioning and for detecting the location of the mechanisms during, and at the end of, moves. The shaft encoders are used to position a mechanism close to the eventual move location, then motor current or voltage feedback is used to determine the opposition to the movement of the mechanism. This opposition, depending on the particular target location, tells the control system whether the mechanism has reached its destination. The amount of opposition is tested to certain limits such that too little opposition means the movement is not complete whereas too much opposition means an obstacle has been encountered.

A human operator can enter a cartridge into the system through a cartridge insertion assembly, or mailslot. Each time an operator enters a cartridge into the mailslot, the control systems rotate the mailslot to receive the cartridge, then move the cartridge either to a cell or the optical drive as requested by the host computer system connected to the autochanger. Cartridges can also be moved from the optical drive or cells to the mailslot and then rotated for removal by the operator.

Data can be located on either side of the optical disk within a cartridge. The control systems use a flip assembly in the autochanger to turn the cartridge over, allowing either side of the disk to be arranged for reading or writing by the optical drive.

The cells are organized into two columns. The control systems use a lateral displacement assembly to move a cartridge from a cell in one column to a cell in the other column, or to move a cartridge between the optical drive, which is located in one of the columns, to a cell in the other column. Also, the mailslot is located in one of the columns, so the control systems use the lateral displacement assembly to move a cartridge from the mailslot to the other column.

The control systems use a cartridge engaging assembly to attach to an exposed end portion of a cartridge positioned in a cell or the optical drive. A longitudinal displacement assembly is used by the control systems to move the cartridge, after attachment, out of the cell or optical drive. After positioning the cartridge vertically and laterally, the longitudinal displacement assembly is then used to move the cartridge into a cell or the optical drive, where the engaging assembly releases the cartridge. Together the cartridge engaging assembly and the longitudinal displacement assembly form an assembly called the transport.

An important aspect of the present invention is that the longitudinal displacement assembly, the flip assembly, the lateral displacement assembly, the engagement assembly, and the insertion assembly are operated by one of the two control systems. The other of the two control systems is used for vertical displacement of the cartridge. The two control systems use control motor shaft encoders and current and voltage feedback to control the force applied by the motors, at specific locations in the system, to operate the various mechanisms.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features, and advantages of the invention will be better understood by reading the following more particular description of the invention, presented in conjunction with the following drawings, wherein:

FIG. **1** shows a block diagram of a computer system incorporating the present invention;

FIG. **2** shows a high level block diagram of the electronics of the present invention;

FIGS. **2A** and **2B** show the mechanical assemblies of the present invention;

FIG. **3** is a detailed block diagram of the control system interface electronics of the invention;

FIG. **4** is a flow diagram of the major modules of the software z of the present invention;

FIG. **5** is a diagram of the servo control system of the present invention;

FIG. **6** is a block diagram of the major modules and data flow involved in a move operation;

FIG. **7** is a flowchart of a move operation;

FIG. **8** is a flowchart of the loop monitor that continuously monitors the forces exerted by the control systems;

FIG. **9** is a block diagram of the major modules and data flow involved in a saturate operation;

FIG. **10** is a flowchart of the saturate operation;

FIG. **11** is a flowchart of a translate operation;

FIG. **12** is a flowchart of removing a cartridge from a cell;

FIG. **13** is a flowchart of inserting a cartridge into a cell;

FIG. **14** is a flowchart of an acceptance test to determine if a cartridge is not extending from a cell;

FIG. **15** is a flowchart of inserting a cartridge into the optical drive;

FIG. **16** is a flowchart of the flip operation;

FIG. **17** is a flowchart of the process of testing for a cartridge in a cell;

FIG. **18** is a flowchart of testing for a cartridge in the optical drive;

FIG. **19** is a flowchart of testing for a cartridge in the transport;

FIG. **20** is a flowchart of the operation of rotating the mailslot inward; and

FIG. **21** is a flowchart of rotating the mailslot outward.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description is of the best presently contemplated mode of carrying out the present invention. This description is not to be taken in a limiting sense but is made merely for the purpose of describing the general principles of the invention. The scope of the invention should be determined by referencing the appended claims.

The optical disk handling system ("autochanger") of the present invention uses two control systems to provide the six motions necessary to move optical disk cartridges from a storage holding unit array ("cells") to an optical disk reading device ("optical drive"). The optical drive, also located in the array, reads or writes data on an optical disk in the cartridge. After the reading or writing operation, the cartridge is replaced in its original cell. A human operator can enter a cartridge into the system through a cartridge insertion assembly ("mailslot"). Each time an operator enters a cartridge into the mailslot, the control systems move the cartridge either to a cell or the optical drive as requested by the host computer system connected to the autochanger. Cartridges can also be moved from the optical